typing and moving joysticks. Obviously the ideal interface should evolve away from the qwerty keyboard and into one that is more natural and incorporates speech recognition. However speech alone is not adequate. For example consider rotating and zooming a three dimensional complex object, or numerical entry applications such as inventory. In particular we are focusing on applications specific to NASA such as being able to perform data entry while constrained by a space suit, controlling remote robotics, and focusing on wearable computing applications.

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Center for Turbulence Research: 2000 Summer Program

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A volume of research reports of the Center for Turbulence Research (CTR) Summer Program has been published. The eighth Summer Program of the CTR took place in the 4-week period, 2 July to 27 July 2000. This was the largest CTR Summer Program to date, involving 40 participants from the United States and nine other countries. Twenty-five Stanford and NASA Ames staff members facilitated and contributed to most of the Summer projects.

Several new topical groups were formed, which reflects a broadening of the CTR's interests from conventional studies of turbulence to the use of turbulence analysis tools in applications such as optimization, nanofluidics, biology, and astrophysical and geophysical flows. The CTR's main role continues to be in providing a forum for the study of turbulence and other multiscale phenomena for engineering analysis. The effect of the Summer Program in facilitating intellectual exchange among leading researchers in turbulence and closely related flow-physics fields is clearly reflected in the proceedings.

The development of the dynamic procedure at the CTR has continued to generate renewed interest in large-eddy simulation (LES) over the past decade. During the Program, new averaging strategies, new equations, and decompositions of the flow field using wavelets were evaluated and tested. In addition, efforts continued in modeling the near-wall turbulence, which remains a pacing item, and in evaluating LES in predicting flow-generated noise. The combustion group continued to attract researchers from around the world. Work on the development and assessment of combustion models was supplemented this year by a large effort to evaluate the use of LES in industrial applications.

The Reynolds-averaged Navier-Stokes (RANS) modeling group continued its effort in developing models that capture the effects of rotation and stratification on turbulence. The ability of RANS models to predict transition was also evaluated. The program benefited from the infusion of novel new ideas from deterministic and stochastic optimization for flow control. These ideas were tested in optimizing microfluidic channels (fig. 1). A novel application of these optimization techniques was the use of evolutionary algorithms in developing strategies for the destruction of aircraft trailing vortices.

The astrophysical group concentrated on protoplanetary disk modeling and simulation. New ideas and transformations of the governing equation promise new advances in this field in the near future. The geophysics group used direct numerical simulation to study sediment transport on a wavy wall and the propagation of internal waves in the upper ocean thermocline. Finally, two new research topics were introduced to the CTR Summer Program, nanofluidics and biology. The biology work on the life cycle of phytoplankton where turbulence plays a key role is a natural extension of CTR's expertise. The work on nanofluidics, which is based on molecular dynamics, is

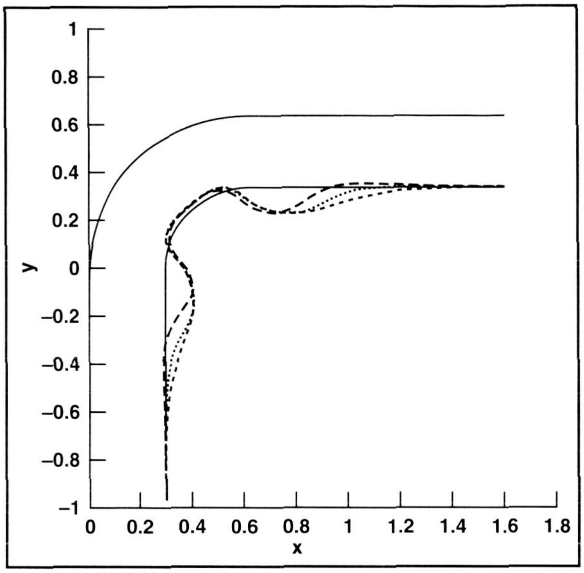

Fig. 1. Design of fluidic channels using a novel shape-optimization algorithm. The various lines show shapes obtained under the same optimization conditions for three admissible spaces with minimum required regularity for the shape. (See http://ctr.stanford.edu/summer00/mohamadi.pdf for a detailed report.)

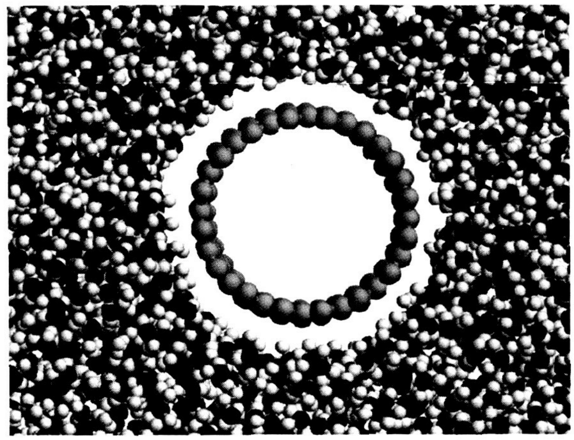

Fig. 2. Snapshot of the atoms from the simulation of a single carbon nanotube in water. (See http://ctr.stanford.edu/summer00/walther.pdf for a detailed report.)

an outgrowth of CTR's expertise in using advanced algorithms and large-scale simulations. Carbon nanotubes in water (fig. 2), and flow in a nanometer-scale channel were simulated during the Summer Program.

There are 29 papers in the proceedings, grouped in six areas. Each group is preceded by an overview provided by its coordinator. The entire proceedings of the 2000 Summer Program are available on the World Wide Web (http://ctr.stanford.edu).

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The Effects of Turbulence on Phytoplankton

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Phytoplankton are photosynthesizing microscopic organisms that inhabit the upper sunlit layer (euphotic zone) of almost all oceans and bodies of fresh water. They are agents for "primary production," the incorporation of carbon from the environment into living organisms, a process that sustains the aquatic food web. Phytoplankton thus control the biogeochemical cycles in aquatic environments and thereby exert a dominant influence on life on Earth. This work is directed at understanding the effects of turbulence on the distribution of phytoplankton and extends earlier modeling efforts through a combination of analysis and computer simulation. The purpose is to better understand the principal qualitative aspects of